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The dynamics of regional inequalities

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Abstract

This paper analyses empirically the dynamics of regional inequalities in GDP per capita. Our starting hypothesis is that the evolution of regional inequalities should follow a bell-shaped curve depending on the level of national economic development. A number of authors going from Kuznets (1955) to Lucas (2000) have provided extensive theoretical arguments along this line suggesting that growth, because of its very nature, is unlikely to appear everywhere at the same time. Regional inequalities should then rise when countries start developing and then fall once a certain level of national economic development is reached as long as spillovers are strong enough to transmit growth and technological progress across regions. We test empirically these predictions by using regional data for a panel of European countries and by making use of semi-parametric estimation techniques. Our results provide strong support for a bell-shaped curve in the relationship between the national GDP per capita level and the extent of regional inequalities independently of the time period and regional administrative units considered. The nature of this non-monotonic relationship is not altered by the inclusion of other possible determinants of regional inequalities. A number of policy implications are derived from our results.

JEL classification: R1, R5, D31
Keywords: Kuznets curve, economic development, regional inequalities, Europe

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1. Introduction

Economists have increasingly paid attention to the role played by knowledge and spillovers in explaining countries' growth differentials and diffusion both across countries and regions, see, for instance, Jones (2004) and Klenow and Rodriguez-Clare (2004). Accordingly, knowledge spillovers should give rise to substantial scale effects in productivity stemming from their non-rivalry nature.[1] However, although knowledge and technological progress are in this regard seen as the main engines of economic development, the latter may inevitably increase rather than decrease regional inequalities since these two elements are very unlikely to be evenly spread both across time and space. As a consequence, economic growth may, at least initially, foster divergence, rather than convergence across spatial units suggesting that convergence may evolve non-linearly. Indeed, when considering the theoretical literature on growth and convergence, a wide array of arguments arise advocating either for the long-term reduction or, to the contrary, for the persistence and self-reinforcing nature of economic inequalities across countries and regions, see, for instance, Galor (1996), Prichett (1997) and Lucas (2000). Elements such as spillover effects and nonlinearities have also been considered in empirical studies providing growing evidence for the non-linear nature of the growth and convergence processes, see, for instance, Durlauf and Johson (1995), Liu and Stengos (1999), Quah (1996b, 1997) and Canova (2004).

Interestingly, the idea that regional inequalities are likely to evolve in a nonlinear way can be traced back as early the 1950s. The evolution of regional inequalities was then usually linked to national economic development paths. As a matter of fact, it was Kuznets (1955) in his analysis of income disparities who suggested the existence of a *"long swing"* in regional income inequalities, where there was first a rise and then a subsequent fall of income differentials caused by the urbanization and industrialization process accompanying national development and the decline of agriculture. Several authors have built on this idea for regional analysis suggesting the existence of a *bell-shaped curve of spatial development* where inequalities should first rise as developed areas

[1] This is a central theme in the works of Romer (1990), Kremer (1993) and Tamura (1996) among others.

benefit from external economies, location of decision-makers, political power and capital and labour mobility, see for instance Myrdal (1957), Hirschman (1958), Williamson (1965) and, more recently, Ottaviano and Thisse (2004).[2]

While a non-linear relationship between regional inequality and national development clearly has important implications for economic theory and policy, there is to the best of our knowledge no explicit econometric study that has set out to investigate its existence, although a number of works have been suggestive of its possibility. In the current paper we explicitly test for the possibility of a non-linear relationship link between national development and regional inequalities using data for EU countries. The EU economy makes arguably for a particularly suitable case study given the sizeable disparities in economic development both across regions and countries, compared to, for instance, the US. One may thus exploit the fact that these countries are on very different positions on their development path, hence allowing one to observe regional inequality across a wide range of economic development levels. To investigate this we use data on GDP per head for European regions between 1975 and 2000. We show using a flexible semi-parametric estimator that the relationship between national GDP per head and regional inequalities follows a bell-shaped curve, suggesting that growth first increases regional inequalities but then tends to lower them as the national level of income continues to rise. This result is robust to considering other OECD countries, alternative geographical units, and after controlling for other potential determinants of regional inequalities such as the degree of international openness, industrial specialization, regional aid, and the level of fiscal decentralization. Our paper is thus, to the best of our knowledge, the first study to provide robust evidence of the bell-shaped relationship between regional inequalities and national economic development.

The remainder of the paper is organized as follows. In Section 2 we review the existing empirical literature concerning the link between national development and regional inequalities. In this section we also present a simple theoretical model to illustrate the main mechanisms at hand.

[2] The evidence concerning the non-linear relationship between urbanization and development is also a well documented fact in urban economics, see, for instance, the seminal work of Alonso (1969).

Sections 3 and 4 present some preliminary evidence and our main econometric results. Section 5 summarises our findings and discusses some policy implications.

2. Revisiting the link between national development and regional inequalities

2.1 Related empirical literature

A number of empirical artefacts tend to support the possibility of a bell shaped relationship between regional inequality and national development. Following the footsteps of Kuznets (1955), Williamson (1965) provides an extensive analysis on the topic by analyzing in details the spillovers mechanism driving the evolution of regional inequalities according to the stages of development of a nation. According to Williamson (1965), spillovers may occur through a number of channels such as migration, capital flows, government policy and interregional trade. Using evidence based on descriptive statistics for a number of countries between the end of the XIXth Century and World War II, he found some supportive evidence for a non-linear relationship between regional inequalities and national development. His conclusions derive from two main empirical facts: first, regional disparities are greater in less developed countries and smaller in the more developed ones; second, over time, regional disparities increase in the less developed countries and decrease in the more developed. Accordingly, regional income inequalities can be considered as a by-product of the development process of a nation and any attempts at lowering them may eventually hamper this process. Kim and Margo (2003) also show that in the US the rise of industrialization during the second half of the nineteenth century has increased regional income disparities, where manufacturing was concentrated in the North and specialization in agricultural activities occurs in the South. By the second half of the twentieth century, however, regional industrial structures converged through a dispersal of agriculture and the rise of services activities across the US States. More recently, in the European context, De la Fuente and Vives (1995) have noted that the European integration process may drive regions located in the same country to divergence in income per capita. Quah (1996a) also observes that the two countries that have reached the highest rates of economic growth, Spain and Portugal, are those that have experienced the most striking rise in regional imbalances. In another contribution, Quah (1999) considers the case of three EU cohesion countries, Spain, Portugal and Greece, and shows that while the first two have experienced strong growth rates and growing regional imbalances during the 1980-89 period, Greece has experienced only modest growth rates accompanied by decreasing income inequalities across its regions.[3] Petrakos and Saratis (2000) also find similar evidence for Greece. These authors find that, during the 1980s, the most developed regions in Greece have faced growing difficulties due to tighter foreign competition implied by the European integration process, while less developed regions were less affected. Petrakos and Saratis (2000) also argue that this may be one of the reasons explaining why regional inequalities have tended to decrease in this country during the 1980ies. In more recent contributions, Davies and Hallet (2000) together with Petrakos et al. (2003) consider more closely the possibility of a bell-shaped curve in regional inequalities for the EU. The former study is essentially descriptive and finds some evidence for growing regional income imbalances for the poorest EU countries while the latter tests econometrically the link between regional inequalities and the level as well as the growth rate of national GDP. However, Petrakos et al. (2003) only allow for GDP level to have a linear effect, which is unlikely to capture the bell-shaped curve of spatial development. This point will be further developed in Section 3. Before presenting our econometric results it is worth setting the basic mechanics underlying the non-linear relationship between regional inequalities and national economic development.

2.2 A simple model of growth, catching-up and technological diffusion

The model presented here is derived from Lucas (2000) where spillovers are the main vehicle of economic development. This author does not directly deal with the relationship between regional inequalities and national development. His model can, however, be used in order to see how growth transition dynamics can influence the evolution of regional inequalities. Let us consider a country composed by a number n of regions. Initially all regions are supposed to have a constant level of income per capita y_0. Now let us consider that growth occurs in only one region at date $t=0$. By

[3] The group of Cohesion countries here refers to the countries entitled to the so-called EU Cohesion fund including, for the period considered here, Ireland, Greece, Portugal and Spain. The Cohesion fund is aimed at favouring economic

making this hypothesis we assume that growth is, at least initially, localized. The other regions will start growing at date *s>0* and each region starts growing at a different date. In making this assumption, we assume that regions differ in their technological capability. The model thus implies a distribution of starting dates characterising regional differences in technological capability. We can thus index regions by the date at which they start growing such that *y(s,t)* will be the income per capita level of a region *s* which starts growing at a date *t*=*s*. The level of income of the innovative region at any date *t* can thus be written as *y(0,t)* such that:

$$y(0,t) = y_0(1+\alpha)^t \tag{1}$$

where α is the steady state growth rate of the leading region and y_0 its initial level of income. When the other regions start growing at a date t>0, they do so according to the following expression:

$$\frac{y(s,t+1)}{y(s,t)} = (1+\alpha)\ \left(\frac{y(0,t)}{y(s,t)}\right)^{\beta} \tag{2}$$

where β is a catch-up rate that we assume to be constant for all the (followers) regions. This term represents the spillover effect described earlier. The starting hypothesis is that, once the leading region starts growing, as time passes and average national income grows, the probability for any region to switch from stagnation to growth will rise and follow a cumulative process. Put differently, the larger the number of existing regions that are in a growth regime, the higher the total amount of knowledge and technological capability available in the economy and the higher the probability for any other region to get access to this knowledge and to start growing. Let consider the (unconditional) probability *F(t)* that any of such region starts growing at date *t*. [4] The average level of income of this economy can thus be described as a weighted sum of the level of income of each region-type, i.e., growing and stagnating regions, as follows:

$$x(t) = \sum_{s\le t} F(s)\ y(s,t) + \left[1 - \sum_{s\le t} F(s)\right] y_0 \tag{3}$$

development of countries with a level of GDP per capita below 90% of the EU average.

[4] The hazard rate is given by $\lambda(t) = \lambda$ and the corresponding survival rate function is $S_t = e^{-\lambda t}$ such that the probability *F(t)* that any region starts growing at a date *t* can be derived in the usual way from the hazard rates model such that $F(t) = \lambda(t)\left[1 - \sum_{s<t} F(s)\right]$

where the probabilities of being in a growth regime or stagnation regime are used as weights. Using this expression, the extent of regional inequalities can be, as in Lucas (2000), described by log standard deviation of income across regions *σ(t)* such that:

$$\sigma(t)^2 = \sum_{s \le t} F(s) \left[\ln\left(\frac{y(s,t)}{x(t)} \right) \right]^2 + \left[1 - \sum_{s \le t} F(s) \right] \left[\ln\left(\frac{y_0}{x(t)} \right) \right]^2 \tag{4}$$

and can be seen as the weighted value of the standard deviation of regional GDP per capita. Figure 1 depicts the relationship between the average level of income (or national average of income per capita) and *σ(t)*.[5] According to this figure, the relationship between the level of regional inequalities and the per capita national income level is non-monotonic and follows a bell-shaped curve. Regional inequalities initially rise as long as the forces for divergence dominate while, after a certain threshold which depends on the level of development of the national economy, regional inequalities start falling. The latter occurs because the probability for a region to be in a growth regime increases while the probability of being in a stagnation regime declines as time goes on and national average income rises. Therefore, a larger country-wide stock of knowledge, or, equivalently, a higher level of average income, improves the level of technology (i.e., the level of income) of each region. The model of economic growth presented here is thus purely a model of technological diffusion where the number of regions benefiting from technological progress rises as the total amount of knowledge in the country increases. One must reckon, however, that the diffusion of growth described by equation (2) looks very much like a black box. The model thus does not rule out, the fact that other mechanisms could as well explain growth transmission across regions. As noted by Lucas (2000), one could as well assume that such spillovers may occur through human capital externalities (Tamura, 1996), through institutions and the removal of barriers to technology adoption such as regulatory or legal contraints as argued by Parente and Prescott (1994), or simply through factor mobility and non-constant returns to capital as in Solow (1956). The identification of these alternative explanations goes beyond the scope of the present study. Here we rather try to assess whether the relationship depicted by Figure 1 holds for different samples of

European countries. One feature of EU economies, is the existing huge levels of income disparities both across regions and countries compare to the US, for instance. The latter means that, by observing the evolution of regional inequalities and level of national economic development and considering all countries/regions together across time one may be able to analyse transition dynamics in regional inequalities. This would amount to consider that any point on the curve plotted in Figure 1 corresponds to the relative values of income per capita and level of regional inequalities of a given country at any date *t*.

3. Data and Preliminary evidence

3.1 Data and measure of regional inequalities

We use data on Gross value added per capita by NUTS2 regions using the Cambridge econometrics database which is based on Eurostat data, see Table A1 in Appendix for further details on the number of regions covered by country.[6] Despite the fact that most studies on EU regions use this regional breakdown, an issue with the NUTS2 regional breakdown is that these regions are not economically homogenous. The consequence is that the geographical definition of regions NUTS2 may sometimes be artificial in order to comply with European standards. For this reason, in section 4 we will use alternative datasets and definition of spatial units in order to check the robustness of our results. The level of national development is represented by the GDP per capita expressed in Purchasing Power Standards (PPS) with one unit of PPS representing approximately one euro.[7] Our measure of regional inequalities is the standard deviation of the logarithm of the GDP per capita following the model presented in Section 2. A number of alternative indicators could have been considered such as the Gini index although one must note that the results obtained with these other possible measures are in line with the ones presented here.[8] Note that the use of logarithm of GDP per capita reduces the potential bias related to the mechanical link between the evolution of the

[5] Values of the parameters used for the numerical examples are given in the Appendix.
[6] Note that we systematically checked the results obtained using the Cambridge Econometrics data by using the regio database which is less complete. The results obtained were nearly identical to the ones presented here.
[7] Table A1 in Appendix provides further details concerning the countries considered and the number of observations available for the different datasets used in the paper.

national GDP and its regional component. For instance, for a given level of population, one can well imagine that variations in the level of all regions GDPs may artificially imply a rise in the absolute inequality. The use of natural logarithm of the GDP per head tends to lower this potential effect. In addition, as usual in the growth literature, our GDP per capita variables are measured relative to the EU average. This allows us to reduce both serial correlation and the effect of potential outliers, see Canova (2004).

3.2 Preliminary evidence

According to the existing evidence for Europe, the poorest EU members have experienced fast catching-up over the past two decades or so and this has translated into rising regional inequalities. In order to provide further evidence on this, we first consider the EU15 countries for which we have the longest time series. More specifically, we consider first the countries which, at the start of the period, had the lowest level of GDP per capita, namely, Greece, Portugal and Spain. Lack of sufficiently disaggregated data at the regional level for Ireland does not allow including evidence for this country despite the fact that Ireland also benefited from the EU Cohesion fund. Table 1 displays the level of national GDP and the standard deviation of regional GDP per capita for these countries. The level of regional inequalities appears to be, on average and for most of the period considered here, higher in the Cohesion country group compared to the rest of the EU. This distinctive feature also holds when considering Cohesion countries individually, except for Greece, which is also the EU15 country with the lowest GDP per capita. One must note, however, that it is rather difficult to draw any conclusive evidence concerning the evolution of regional inequalities given that this indicator is rather volatile, especially, but not exclusively, for the cohesion country group as shown in Table 2. Despite this, we can still identify two distinct periods concerning the evolution of regional inequalities and convergence in the Cohesion countries. The first is the 1975-1985 period, marked by slow economic growth in the EU as a whole, and declining regional inequalities in Spain, Greece and Portugal. By contrast, the following two periods were

[8] Note also that, in order to check whether the standard deviation of regional GDP per capita was influenced by the number of regions by country, we computed correlation these two variables for the EU15 and it was equal to –0.33.

characterized by fast catching-up and rising regional inequalities. These two periods are also marked by the accession of two cohesion countries in 1986, namely Spain and Portugal, with initial GDP per capita much lower than the EU15 average. During 1986-1992 income per capita converged steadily in Portugal and Spain together with a rise in regional income inequalities. In Greece, however, the slight decline in income per capita relative to the EU average was accompanied by a rise in regional inequality compared to the rest of the EU but remaining at levels well below the EU average. The period 1992-2000 is characterized by a rather stable level of regional inequalities in Spain and rising inequalities in Greece and Portugal. This rise, in turn, corresponds to a rapid convergence of GDP per capita for the last two countries.

The evidence regarding the rise in regional inequalities that accompanies national economic development is even more pronounced when considering the countries that joined the EU in 2004. Table 3 provides detailed statistics for these and shows that, as for the Cohesion countries, these countries display, on average, higher regional inequalities than the EU15 countries, including the Cohesion countries. In addition, they have almost invariably all experienced a continuous increase in the level of regional inequalities during the period 1995-2000, except Bulgaria, Poland and Slovenia. While part of this evolution is probably due to the transition from a planned to a market-oriented economy, most of the impact of this process at the regional level was experienced in the early 1990s. It follows that a large part of the rise in regional imbalances is likely to be due to the rapid catching-up process experienced by these countries during the past decade as shown by Petrakos et al. (2000). However, not all countries have been catching-up during the 1995-2000 period. Countries such as Bulgaria, the Czech Republic and Romania have even seen the level of their GDP per capita compared to the EU15 average decline during these years. On average, these countries have also experienced a less pronounced rise in regional inequalities.[9] One must reckon that these preliminary results face some limitations. First, one needs to further check whether non-observable country-specific features influence the nature of this relationship. Second, as mentioned

[9] This can be seen by splitting the Eastern European countries considered here into two samples, those that have caught-up and those that have not. If one considers weighted average (using country-level population as weight), the non

earlier, regional inequalities have not only risen in the poorest EU countries but also in some of the richest ones. It follows that the non-linear relationship between economic development and regional inequalities is hard to detect from the descriptive statistics presented above. The existing evidence is essentially focused on the ascending part of the bell-shaped curve (i.e. increasing disparities in poorer countries) while much less evidence is available concerning the descending part (i.e. decreasing disparities in richer countries). Part of the reason for this may be due to the fact that the processes underlying the descending part might be less automatic than for the ascending part and much more depending on pro-active regional policy and/or on implicit redistribution schemes. The evidence for Europe suggests that these policy-related factors play an important role in smoothing income inequalities in some countries such as Germany or France, for instance, see European Commission (2000) and OECD (2004). In order to go a step further in the analysis, the next section provides econometric result based on parametric and semi-parametric methods.

4. Econometric Analysis

4.1 Econometric methodology

In this section we present the econometric methodology used to study the relationship between the level of economic development represented by the relative (to the EU) level of GDP per capita (that we call Y) and the relative (to the EU) level of regional inequalities, represented by X, both variables being observed at the country-level. Following our underlying hypotheses, the level of economic development of a country should explain where this country lies in terms of regional inequalities with poorer countries experiencing growing regional imbalances as they catch up with richer countries. One way to test econometrically the relationship between Y and X is to run a simple parametric OLS estimation including both country and time dummies to control for country specific time invariant unobservables and time specific factors common to all countries in the sample. An example of the results obtained with such method can be provided by using, for instance, the data concerning the EU15 regions over the 1975-2000 period. We include both the

catching-up countries have seen the level of regional inequalities to increase by around 21% while the catching-up countries have more than doubled this figure with a rise equal to 43%.

level of national GDP per capita and its square-term in order to capture the non-linear relationship described earlier. The results of running the parametric estimations are given in the first column of Table 4. As can be seen, our results suggest that national prosperity acts to decrease regional inequalities while the square value of this variable is insignificant. However, a simple Ramsey RESET test suggests that the specified functional form may not be correct. We also experimented with other higher order terms of the national GDP per capita but were unable to obtain a RESET test statistic that did not suggest misspecification.[10] One problem, of course, with simply using higher order terms to estimate a possibly non-linear relationship is that even these place fairly strong restrictions on the possible link between the dependent variable and the explanatory variable of interest that may not reflect the true underlying relationship. A more flexible approach to tackle non-linearity issues in growth and convergence studies is to use semi-parametric methods, as suggested by Durlauf (2001). In this way one can investigate the possible non-linearity of the relationship between regional inequality and national development, while also allowing for the (linear) effect of other conditioning variables. We follow the semi-parametric methodology proposed by Robinson (1988) using the Kernel regression estimator.[11] Accordingly, one can consider the following equation to be estimated:

$$Y = \alpha + g(X) + \delta Z + u \qquad (5)$$

where Z are a set of explanatory variables that are assumed to have a linear effect on Y, $g(.)$ is a smooth and continuous, possibly non-linear, unknown function of X, and u is a random error term. Robinson's methodology proceeds in two steps. First, an estimator of δ, $\hat{\delta}$,can be obtained by using OLS on:

$$Y - E(Y|X) = \delta\, [Z - E(Z|X)\,] + v \qquad (6)$$

[10] The result of the RESET test when including the level of national GDP only displays a F-value equal to 10.84 and significant at 1%. When including this variable and its squared term the F-test value is 8.18 and is also significant at 1%.
[11] See Blundell and Duncan (1998) for details and a helpful discussion of the implementation of this method.

Where v satisfies $E(v|X,Z) = 0$ and $E(Y|X)$ and $E(Z|X)$ are estimated using the Nadaraya-Watson non-parametric estimator. For instance, the estimation of $E(Y|X)$, $\hat{m}_Y(X)$, can be written as [12]

$$\hat{m}_Y(X) = \frac{\sum_{i=1}^{n} K_h(x - X_i)Y_i}{\sum_{i=1}^{n} K_h(x - X_i)} \tag{7}$$

such that $i=1...n$ are the n number of observations, $K_h()$ is the shape function, commonly referred to as the Kernel, that is a continuous, bounded and real function that integrates to one and acts as a weighting function of observations around X and depends on the choice of bandwith h. More specifically, this technique corresponds to estimating the regression function at a particular point by locally fitting constants to the data via weighted least squares, where those observations closer to the chosen point have more influence on the regression estimate than those further away, as determined by the choice of h and K. An important appeal of this sort of technique is that it avoids any parametric assumptions regarding $E(Y|X)$ and thus about its functional form or error structure. In a second step, the function g from (5) can be estimated by carrying out a nonparametric regression of $(Y-Z)$ on X such that $\hat{\delta}$ is the OLS estimator of:

$$Y - \hat{m}_{\tilde{y}}(X) = \delta(Z - \hat{m}_Z(X)) + \varepsilon \tag{8}$$

where ε is a random error term. Intuitively, $\hat{g}(X)$ is the estimate of $g(X)$ after the independent effect(s) of Z on Y has been removed. Given that the estimate of $\hat{g}(X)$ is at least in part based on non-parametric estimation techniques, one cannot subject it to the standard statistical type tests e.g., t-test. One can, however, relatively easily calculate upper and lower pointwise confidence bands as suggested by Härdle (1990).[13] For all our estimations we use a Gaussian kernel for K_h and an optimal bandwidth h such that $h = \frac{0.9m}{n^{1/5}}$ where m = $(\hat{\sigma}^2(X) \times$ (interquantile range)$_X$ / 1.349).

[12] See Nadaraya (1964) and Watson (1964).
[13] One should note that the confidence band proposed by Härdle (1990) ignores the possible approximation error bias. Including this would complicate the expression considerably since the bias is a complicated function of the first and second derivatives of g(X). This bias tends to be highest at sudden peaks of and at the necessarily truncated left and

Note that the size of the estimated error variance, $\hat{\sigma}^2(X)$, at any point of X will depend proportionally on the marginal distribution of X. In other words the accuracy of the estimate of *g(X)* at X is positively related to the density of other observations around that point. In order to visualize this effect we, as suggested by Härdle (1990), calculate the pointwise confidence bands at points chosen according to the distribution of X. Specifically, we chose points so that one per cent of the observations lie between them.[14] In terms of explanatory control variables to be included when estimating (5) we first utilised time and country specific dummies. The former allows for year specific effects that are common to all countries, while the latter controls for unspecified time invariant country specific effects that could bias results. In a later stage we also included a measure of industrial specialisation, a measure of fiscal decentralisation, EU regional aid and trade openness as additional control variables.

4.2 Results for the EU

Our semi-parametric kernel regression estimate of *g(X)* along with pointwise confidence bands for the EU15 countries over the 1975-2000 period is shown in Figure 2. Before commenting on this, it is important to point out that, in contrast to the horizontal range, one cannot read too much into the vertical scale of the Figures, as the range is derived from predicted values where there is a problem of non-identification of an unrestricted intercept term, and thus does not completely overlap with actual observed inequality values. However, this is not necessarily a problem since we are mainly interested, as one is normally when implementing this class of semi-parametric estimators, in the slope of the curve and how this changes across the range of explanatory variable in question, i.e., national development. The distance between the confidence interval points and their vertical distance from the estimated Figure suggests that our estimates are made with some precision. Even at the end points, where estimates normally tend to be relatively poorer because the neighbourhood around points is necessarily truncated, we obtain fairly accurate estimates. Most importantly, in terms of the shape of the relationship between regional inequalities and national

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right boundaries of the data. However, if h is chosen proportional to 1/n(1/5) times a sequence that tends slowly to zero then the bias vanishes asymptotically for the interior points, see Härdle (1990) and Wand and Jones (1995).

economic development one discovers a clear bell-shaped relationship, which plateaus out at high levels of development. In other words, at early stages of economic development regional inequalities tend to rise, but, after reaching a peak, this trend is reversed and regional inequalities fall. There are a number of reasons to suspect that our estimations are potentially biased. First, there is an obvious link between the regional GDP series used to compute our inequality measure and the national GDP per head used as main explanatory variable as evidenced in the model described in Section 2.2. Second, economic theory and empirical evidence suggest that the regional economic inequalities may directly affect regional economic performance through agglomeration economies, see Fujita and Thisse (2002) for a theoretical review and Ciccone and Hall (1996) and Ciccone (2002) for empirical evidence. One way to handle the potential endogeneity of the level of national GDP per head is to use as instrument past levels of logged GPP per head as usually done in the convergence literature, see Barro and Sala-i-Martin (2004, ch.11). Figure 3 plots our semi-parametric estimations using alternatively the actual value of the GDP per capita as explanatory variable, as in Figure 2, together with the 2-year lagged and the 5-year lagged value of the same variable. For visual convenience we only report the estimations without the confidence bands. According to these results, the bell-shaped curves found earlier still hold. Furthermore, the small bumps observed in Figure 2 both on the right and left hand-side of the sample estimates are smoothed and this is especially true when using the 5-year lagged series of GDP per head. It follows that, in order to get estimates that are less sensitive to measurement errors and potential endogeneity, in what follows we will use the lagged 2-year level of national GDP per head as main explanatory variable. We use the 2-year lag instead of the 5-year lag of the same variable given the sample size restriction, especially when considering alternative countries and time periods where the data restriction issue is even more severe.

It is interesting to also examine whether the bell-shaped curve holds for the new Member States that entered the EU in 2004. Unfortunately the small sample of new EU entrants, ten countries over five years, is not enough to produce any separate estimates for these countries alone.

[14] For the endpoints we chose the 1 and 99 percentiles of the distribution.

Instead we include them with our EU sample for the period 1995-2000 and thus, any result must be roughly viewed in contrast to the ones found for the later period of the EU15 on their own. However, introducing these countries allows one to consider a wider range of development levels. This should also allow us to better capture the bell-shaped curve hypothesis in that we may expect eastern European countries to catch-up economically with respect to their western counterparts. This, in turn, may have important implications in terms of regional inequalities in these countries if the bell-shaped curve hypothesis is verified. The results of this exercise are shown in Figure 4. These results give strong support to our starting hypothesis as our estimations now cover a much wider range of GDP per capita levels with both the upward and downward part of the bell-shaped curve being well explained by our estimations. The regional data used for the new member states is not always based on the same spatial disaggregation, however. In fact, the NUTS2 level which was used for the EU15countries sample is only available for Poland, the Czech republic, Hungary and Slovakia.[15] In order to see whether these influenced our results we estimated again our equation including only the new member states for which NUTS2 regional data was available. Results displayed in Figure 5 shows indeed that our results remain broadly in line with those presented in Figure 4 although the precision of our estimate is clearly less satisfactory due to the loss of data.

One can use our estimates from the semi-parametric regressions to say something further about where countries' position along the national prosperity/regional inequality path are currently and have lied in the past. For this we first use information at what level of development (i.e., at what value on the horizontal axis) the turning point lies from our most general Figure, i.e., Figure 2. Accordingly, the peak occurs around a value of the relative GDP level of 0.85. Referring to the actual values of this variable for EU15 countries in 1975 in Table 1, one finds that at the beginning of our sample period, Greece and Portugal were clearly located to the left of the turning point, while Spain was slightly to the left. Thus, particularly for the former two countries, any increase in relative national prosperity was to go hand in hand with a rise in regional inequality. In contrast, the remaining members of the EU15 would have experienced a fall in regional income dispersion

[15] For the other countries the NUTS3 level was used instead given that NUTS2 data was not available.

with further economic growth. One should note that, while some countries did experience changes in their national prosperity, this was never enough to push them to the opposing part of the curve.

We also used our estimated turning point from Figure 5 to assess positions along the path for our entire EU25 sample in 2000. Accordingly, the peak occurs when the relative GDP ratio measure is equal to 0.55. Table 3 reveals that in 2000, all the new EU Member States, except the Czech Republic and Slovenia, were located to the left of the turning point and thus their further development is likely to result in further inequality. In contrast, the Czech Republic and Slovenia are on the downward sloping part of the Figure, where thus further economic growth should lower regional income discrepancies.

Although, because of their small number of regions, Ireland and Denmark were not used in the estimation, we can still say something about these countries using the values of their actual levels of GDP per head in 1975 and 2000. Comparing these to the relative turning point found from Figure 2, it is apparent that Denmark has been located on the downward sloping part of the relationship. In contrast, Ireland constitutes the only nation that was able to move from a point of national prosperity where small increases caused further regional disparities, to enjoying a level of economic development where further growth can reduce regional inequalities. While, as mentioned earlier, our dataset does not contain information at the regional level for this country, evidence provided by Davies and Hallet (2000), tend to support this contention. Following these authors, Irish spectacular growth in the 1980s and the 1990s was essentially localized in the Southern and Eastern regions, in particular Dublin and its surrounding areas. The rest of Ireland started to catch-up at the end of the 1990s and also converged to the EU average.

4.3 Results using alternative datasets: Functional Urban Areas and OECD data

In order to check the robustness of our results we have used two alternative datasets. The first dataset used is from a database compiled by the London School of Economics on European Functional Urban Areas (FURs). Following Magrini (1999, 2004), if we are to evaluate growth and convergence dynamics across regions correctly, the spatial units used should abstract from commuting patterns. The FURs are precisely defined on the basis of core cities identified by concentrations of employment and surrounding areas on the basis of commuting data. They are broadly similar in concept to the (Standard) Metropolitan Statistical Areas used in the US, see Cheshire and Hay (1989) for more details. It is also worth to point out that the FUR areas do not cover the whole territory of the countries they belong to. We use data on the FURs for seven EU countries for the period 1977-1996.[16]

The second dataset comes from the Territorial Statistics of the OECD. Statistics are collected through the National Statistical Offices of OECD Member countries and Eurostat. National censuses and surveys are undertaken in different time periods and years of observation may vary between countries. The appeal of this database is that it covers non-EU countries such as Australia, Canada, the US, Mexico, Norway and Japan in addition to the EU counties used until now. In order to ensure time consistency for all countries these territorial Statistics are organised in four waves: Wave 1 (about 1980), Wave 2 (about 1990), Wave 3 (about 1995) and Wave 4 (about 2000). GDP figures are expressed in constant US dollars. Data are collected at the level of 300 regions of the OECD area. Initially data on Denmark, Ireland and Luxembourg were available with the OECD database but concerned very few regions. These countries were thus not considered in the analysis. In addition, in the case of Germany, the OECD database includes Eastern German Länder after 1990, which greatly influences the level of regional inequalities. Only data before 1990 was thus used for this country.

Figure 6 displays our semi-parametric estimates using the Functional Urban Areas. As can be seen, these data are probably least supportive of bell shaped relationship in that, while low levels of national development are associated with rising inequalities and after a certain turning point there is a clear fall in regional inequality, regional inequalities marginally rise with very high levels of development. Regional inequalities would then also rise for relatively high levels of national GDP per capita indicating that some divergence may occur for these countries, although the slope of the curve tends to be much lower for relatively rich compared to relatively poor countries. This result is

[16] The data is in GDP per capita in US $ expressed in PPP terms, see the Table A1 in Appendix for more details.

not totally contradictory with our starting hypothesis given that the FUR data does not cover the whole set of EU regions but rather compare level of income of a limited number of metropolitan areas for each of the countries included in the sample. Given that these areas play a major role in fostering growth and technological diffusion, one may well expect this to be true across all countries and not only for the poorest ones. Our results show that these effects are stronger the poorer the country is, suggesting that metropolitan areas are more likely to play a greater role in fostering the catching-up of the poorest countries compared to the wealthier ones. The results using OECD Territorital Statistics are depicted in Figure 7. As with our regional databases there is a clear bell-shaped relationship, although this is not as pronounced as with our most of European data. In addition, point estimates appear to be less significant, especially for low levels of GDP per head which may well be due to the small number of observations available for estimations. However, the bell-shaped curve evidenced earlier remains also valid here.

4.4 Controlling for additional explanatory variables

The preceding analysis assumes that regional inequalities are influenced by the level of national economic development only. This assumption is rather restrictive and our results can potentially suffer from the omission of other (possibly) important determinants of regional inequalities. We thus check whether the general relationship between regional inequalities and national economic development holds when including additional explanatory variables. In this regard, we would ideally like to include all potential determinants as suggested by the existing empirical growth and trade literature. In practice, however, regional data on these topics are rarely available and/or of poor quality, we thus chose to focus on a limited number of variables and by considering the European NUTS2 regions for which data are most complete. Given these limitations, the variables to be considered in this section will be a measure of national trade-openness, regional industrial specialization, and a measure of the degree of regional fiscal decentralization.[17]

The first additional explanatory variable to be considered is a measure of international trade openness. The inclusion of this variable can be seen as important given the fact that the model presented in section 2 assumes that spillovers occur only at a national level, excluding international technological spillovers related with trade intensity which have been found to be important in the literature, see Coe and Helpman (1995). A number of authors including, in particular, Gianetti (2002), directly relate the rise of European regional inequalities in the 1990s to the setting-up of the Single Market Program and the rise in trade integration that followed. Following Gianetti (2002), economic integration intensifies international knowledge spillovers (compared to within-country spillovers) which has favoured country rather than region-level convergence in the EU during the implementation of the Single Market Program.[18] The empirical literature on trade and growth generally uses the ratio of total trade (import + export) to GDP in order to measure trade openness, see Frankel and Rose (2002). Recently, however, Alcalá and Ciccone (2004) have criticized the use of such index to measure the impact of trade on cross-country productivity given that trade tends to raise the relative price of non-tradable goods. In order to circumvent this issue they propose instead two alternative indices: the *real openness index*, which is the sum of imports *plus* exports expressed in common currency (here the euro) relative to the GDP expressed in PPP terms and the *tradable GDP openness* which is defined as the sum of nominal export and import divided by the nominal value of GDP in the tradable sector. In our estimations we will use the traditional openness indicators as well as the two alternative indicators proposed by Alcalá and Ciccone (2004).

[17] Additional explanatory variables such as labour mobility and differences in regional educational level were also initially considered but were dismissed given that they are only available on regional basis for few countries and only for very short time spans. Table A2 in Appendix provides further details on data sources and definitions of the variables.

[18] It is worth noting, however, that recent papers looking more specifically at knowledge spillovers in the EU find, however, that R&D spillovers in the EU are subject to strong distance-decay effects with a significance influence exerted by national borders, see Bottazzi and Peri (2003). Accordingly, despite the fact that increased economic integration tend to lower the barriers to technological spillovers, the diffusion of knowledge and innovation in the EU have still strong country-specific components.

The second variable to be considered is a measure of regional industrial specialisation. Here we use the country/year average of the so-called *Krugman* indicator which corresponds to the expression: $K_{j,k,t} = 0.5\sum_{s}\left|x_{s,j,t} - x_{s,k,t}\right|$ where $x_{s,j,t}$ is the share of sector *s* in total employment of region *j* at a given year *t*. The indicator value oscillates between 0 and 1. The indicator will be low when two regions *j* and *k* have similar industrial structures (i.e. a similar distribution of employment shares across industries), and high otherwise. The use of such an indicator was made popular after the study by Kenen (1969) who first advocated that sectoral specialization may play an important role in determining regional economic fluctuations and growth patters, see also Clark and van Wincoop (2002) for further discussion on this issue. In the same vein, Gianetti (2002) shows that regions with similar technological capabilities (directly linked to the specialization of regions in traditional sectors) have converged substantially while the rest of regions have displayed some tendency to diverge over the period considered.

The third additional variable to be considered is a measure of fiscal decentralization since it may also have been the cause of growing economic divergence in the EU. Evidence in this direction has recently been provided by Rodriguez-Pose (1996) and Rodriguez-Pose and Gill (2003a), for instance.[19] These studies relate to the well-known Oates theorem on fiscal decentralization according to which differences in preferences about public goods across regions will require a decentralized provision of such goods in order to improve regional economic performance, see Carrion i Silvestre et al. (2004). Other authors, however, have found rather contradictory results finding little evidence on the impact of fiscal decentralization on regional growth, see for instance Xie et al. (1999) and Davoodi and Zou (1998). The question of the relationship between fiscal decentralization, national growth and regional inequalities thus appears to be an empirical one. In order to control for the possible influence of fiscal regional decentralisation we use the indicator developed by the World Bank which is based on data from the IMF's Government Finance Statistics. This indicator is the percentage of total expenditures accounted for by sub-national

[19] Stansel (2005) provides similar evidence for the US.

governments, see Table A2 in Annex for further details. It is worth noting that this indicator accounts for regional as well as local public spending decentralization which gives full account of the level of fiscal decentralization likely to have an impact on the extent of regional inequalities. Given that countries differ in terms of the level of public spending as share of GDP, we also use as an alternative measure for fiscal decentralization the share of sub-national public expenditures in percentage of national GDP.

The fourth extra-explanatory variable is a measure of the impact of EU regional policy whose main objective is to boost convergence and reduce regional economic development disparities in EU regions and countries. More specifically, since the end of the 1980s, European structural funds have largely benefited those EU regions with a GDP per capita lower than 75% of the EU average (the so-called Objective 1 regions).[20] These regions, in turn, are mainly concentrated in the member states with the lowest GDP per capita. Over the period 1989-1999 these funds have been substantial representing, on average, around 2% of the GDP of the Cohesion countries group (including Spain, Portugal, Greece and Ireland) against 0.12% for the rest of the EU.[21] Despite their importance, the effective impact of EU structural funds remains inconclusive with a number of authors suggesting that, at best, their impact was negligible, see Boldrin and Canova (2001) and Beugelsdijk and Eijffinger (2003). De la Fuente (2002), however, finds a positive and significant impact of structural funds on the economic development of Spanish regions. In order to control for the possible influence of EU regional policy we use an additional explanatory variable which is the level of Structural Funds as percentage of national GDP.

As an initial step we first ran simple OLS specifications including these additional explanatory variables in order to see whether their impact on regional inequality coincides with a priori expectations and thus whether they are likely to serve as good proxies of their intended

[20] Another important component of EU cohesion policy is the Cohesion fund. While this fund may also have an impact on regional inequalities, this impact is less clear-cut given that it is attributed on a national basis (the criterion being that the EU country must have a GDP per head below 90% of the EU average) in order to boost growth mainly through public investment in transport and energy infrastructure and also for the protection of the environment.

[21] Sources: Annual reports of the EU Court of Auditors for data from 1976-1996 and EU Commission's Annual report on allocated expenditure from 1997 on.

purpose. In doing so we also included our *national level of GDP per capita* variable and its value squared. The results of this specification are given in the second column of Table 4. The estimated signs on these extra-variables coincide with a priori expectations, although it is only significant for the structural funds proxy. In columns 3 and 4 we experimented with alternative proxies of fiscal decentralisation and openness as discussed above. Notably, the openness variables is now statistically significant and of the expected sign. In the fifth column of Table 4 we also included our dissimilarity index and, as can be seen, while it is of the expected sign, the coefficient is insignificant. Note also that our measure of EU regional aid is very likely to be correlated with the level of national GDP per capita given that EU funds are essentially destined to EU poorest member states. This may explain why the coefficient on this variable is rather unstable depending on the chosen specification.

In Figures 8 through 11 we thus proceeded and re-estimated our semi-parametric specification including these additional control variables in various combinations. The results obtained in these figures must be compared to the one obtained previously in Figure 2 where we included the *national level of GDP per capita* only as explanatory variable. Accordingly, regardless of what fiscal decentralisation or openness variable we use, the estimated shape of the regional inequality-national development link remains bell-shaped. In Figure 11 we also included our dissimilarity index, although one must note that this meant reducing our sample period to start from the 1980s. Nevertheless, one still observes the outlines of a bell-shaped curve.

5. Summary and conclusion

In this paper we examine the link between national economic development and regional inequalities for a number of European countries and find strong evidence for a bell-shaped relationship between these two variables. This evidence shows in particular that regional inequalities inevitably rise as economic development proceeds but then tend to decline once a certain level of national economic development is reached. Our results fit well with the original predictions of Kuznets (1955) as well as with a model *à la* Tamura (1996) and Lucas (2000) where the transition dynamics of regional economies towards their steady state level of income can generate such a curve and where spillovers play a central role in transmitting growth and technological progress across regions. Despite the fact that our results concern essentially the EU experience, the pattern of regional development they describe provide a fairly general idea about the relationship between national development and regional inequalities. Indeed, results including other OECD countries tend to confirm the existence of such bell-shaped curve in regional development for non-EU countries.

Our findings have also important policy implications for EU Cohesion policy. This policy is aimed at boosting convergence and catching-up of lagging EU regions and at reducing regional inequalities across the EU. The evidence presented here implies that some degree of regional inequality is hardly avoidable, at least at the initial stages of development. The main reason for this is that growth, because of its very nature, is unlikely to appear everywhere at the same time. It follows that some degree of heterogeneity in regional economic development will necessarily appear as countries are engaged into fast economic catching-up. This interpretation is further reinforced by our results concerning European metropolitan areas. Cities are likely to play a major role in fostering growth and technological diffusion. Our results tend to corroborate the fact that this role is, however, likely to be more important for the relatively poor, rather than the relatively rich EU countries. Our results thus suggest that regional policy and public investment should aim at boosting national growth in order to guarantee greater national prosperity levels at the expense of temporarily rising inequality, especially for the least developed countries such as the new EU member states. In this sense, our results tend to support the findings of a recent paper by de la Fuente (2004) who estimates that, in the case of Spain, which has largely benefiting from EU aid since the late 1980ies, the allocation structural funds would have provided greater welfare through more concentration on the most dynamic regions in order to favour nation-wide growth. As suggested by de la Fuente (2004), the cost of re-shifting funds toward the most dynamic regions is likely to be mitigated by national-level interpersonal income redistribution mechanisms. In our analysis of the evolution of regional inequalities we try to take into account policy-related elements such as Structural Funds and fiscal decentralisation variables which could possibly explain the evolution of regional inequalities in the EU. However, other policy-related factors such as countries' own pro-active regional policy or redistribution mechanisms through social security schemes might also influence the evolution of regional inequalities. A possible extension of this work could be to consider these elements in order to analyse the efficiency of public policies addressing regional disparities by taking explicitly into account the non-linearity inherent to the evolution of regional inequalities evidenced in this paper.

References

Alcalá, F. and A. Ciccone (2004), Trade and Productivity, *Quarterly Journal of Economics* 129(2), 613-646.

Alonso, W. (1969), Urban and Regional Imbalances in Economic Developments, *Economic Development and Cultural Change* 17, 1-14.

Barro, R.J. and X. Sala-i-Martin (2004), Economic Growth, 2nd Edition, MIT Press (Ed.).

Beugelsdijk, M. and S.C.W. Eijffinger (2003), The Effectiveness of Structural Policy in the European Union: an empirical analysis for the EU15 during the period 1995-2001, *CEPR discussion paper* 3879.

Blundell, R., Duncan, A., (1998). Kernel regression in empirical microeconomics, *Journal of Human Resources* 33 (1), 62–87.

Boldrin, M. and F. Canova (2001). Europe's regions: income disparities and regional policies, *Economic Policy* 16, 206-253.

Bottazzi, L. and G. Peri, (2003), "Innovation and spillovers in regions: Evidence from European patent data", *European Economic Review* 47(4), 687-710

Canova, F., (2004), "Testing for convergence clubs in income per capita: a predictive density approach", *International Economic Review* 45(1), 49-77.

Cheshire, P.C and D.G. Hay (1989), Urban problems in Western Europe. An Economic Analysis, Unwin Hyman, London.

Ciccone, A. and Hall, R., (1996). Productivity and the density of economic activity. American Economic Review 86, 54-70.

Ciccone, A., (2002). Agglomeration-effects in Europe, European Economic Review 46(2), 213-227.

Clark, T. E. and van Wincoop, E. (2001). 'Borders and business cycles', *Journal of International Economics* 55, pp. 59–85.

Coe, D. T. and E. Helpman, (1995), International R&D spillovers, *European Economic Review*, 39(5), 859-887.

Davies, S. and M. Hallet, (2002). Interactions between National and Regional Development, HWWA Discussion Paper 207, Hamburg Institute of International Economics.

Davoodi, H. and H. Zou, (1998), Fiscal decentralization and economic growth: a cross-country study, *Journal of Urban Economics* 43, 244-257.

De la Fuente, A. and X. Vives, (1995). Infrastructure and Education as instruments of regional policy: evidence from Spain. *Economic Policy* 20, 13-51.

De la Fuente, A. (2002) Does cohesion policy work? Some general considerations and evidence from Spain, IAE-CSIC Barcelona, *mimeo*.

De la Fuente, A. (2003), The effect of Structural Fund spending on the Spanish regions: an assessment of the 1994-99 Objective 1 CSF, *FEDEA working paper* 2003-11, Madrid.

De la Fuente, A. (2004). Second-best Redistribution Through Public investment: A Characterization, an Empirical Test and an Application to the Case of Spain", *Regional Science and Urban Economics* 34(5), 489-618.

Durlauf, S.N. (2001), Manifesto for a growth econometrics, *Journal of Econometrics* 100, 65-69.

Durlauf, S. N. and P.A. Johnson (1995), "Multiple regimes and cross-country growth behaviour", *Journal of Applied Econometrics* 10(4), 365-84."

European Commission (2000), Real Convergence and Catching-up in the EU (ch. 5), In: The EU Economy Review, 2000 Review, Brussels.

Frankel, J.A. and A. Rose (2002), "An Estimate of the Effect of Common Currencies on Trade and Income", *Quarterly Journal of Economics* 117(2), 437-466.

Fujita, M. and J.F. Thisse, (2002). Economics of Agglomeration. Cities, Industrial Location and Regional Growth. Cambridge University Press.

Galor, O., (1996), "Convergence? Inferences from theoretical models", *Economic Journal* 106(437), 1056-1069.

Gianetti, M (2002), The effects of integration on regional disparities: Convergence, divergence or both? *European Economic Review* 46, 539-567.

Härdle, W. (1990), "Applied non-parametric regression", Econometric Society Monographs series 19, Cambridge University Press.

Hirschman, A.O., (1958). *The Strategy of Development*, New Haven, CN : Yale University Press

Head, K and Th. Mayer, (2000). "Non-Europe: The Magnitude and Causes of Market Fragmentation in the EU", *The Review of World Economics/Weltwirtschaftliches* Archiv 136(2): 284-314.

Iimi, A. (2005), Decentralization and economic growth revisited: an empirical note, *Journal of Urban Economics*, *forthcoming*.

Jones; CH. I (2004), Growth and ideas, *NBER working paper* 10767.

Kenen, P. B. (1969). 'The theory of optimum currency areas: an eclectic view. In: Mundell R. and Swoboda A. K. (eds), Monetary Problems of the International Economy, University of Chicago Press, Chicago, IL, pp. 41–60.

Kim, S. and R.A. Margo, (2003), Historical perspectives on U.S. economic geography, In: *Handbook of Urban and Regional Economics*, J.V. Henderson and J-F Thisse (eds).

Kremer, M. (1993), "Population Growth and Technological Change: One Million B.C. to 1990", *Quarterly Journal of Economics* 108: 681-716.

Kuznets, S., (1955), Economic Growth and Income Inequality, *American Economic Review* 45(1), 1-28.

Li, Q. and Wang, S. (1998). A Simple Consistent Bootstrap Test for a Parametric Regression Function, *Journal of Econometrics,* 87, 145-165.

Liu, Z. and T. Stengos, (1999), Non-linearities in Cross-country Growth Regressions: A semiparametric Approach, *Journal of Applied Econometrics* 14(5), 527-538.

Lucas, R.E., (1988). "On the Mechanics of Economic Development", *Journal of Monetary Economics* 22, 3-42.

Lucas, R.E. (2000), "Some macroeconomics for the 21st Centrury", *Journal of Economic Perspectives* 14 (1), 159-168.

Organisation for Economic Cooperation and Development, (2004), Regions at work, OECD Economic Survey Euro area n°76, 153-248.

Magrini, S. (1999), The evolution of income disparities among the regions of the European Union, *Regional Science and Urban Economics* 29(2), 257-281.

Magrini, S. (2004): "Regional (Di)Convergence", In: V. Henderson and J.-F. Thisse (eds.), *Handbook of Urban and Regional Economics*, Elsevier SciencePublishers, Amsterdam.

Myrdal, G., (1957). *Economic Theory and Underdeveloped Regions*. London : Duckworth.

Ottaviano, G.P. and J.F. Thisse (2003). Agglomeration and economic geography, In: *Handbook of Urban and Regional Economics*, J.V. Henderson and J-F Thisse (eds).

Paap, R. and H. van Djik (1998), "Distribution and mobility of Wealth of Nationals", *European Economic Review* 42, 1269-93.

Parente, S.L. and E.C. Prescott, (1994), "Barriers to Technology Adoption and Development", *Journal of Political Economy* 102(2), 298-321.

Petrakos, G. and Saratsis, Y., (2000), Regional Inequalities in Greece. *Papers in Regional Science* 79(1), 57-74.

Petrakos, G., A. Rodríguez-Pose and A. Rovolis, (2003). Growth, integration and regional inequality in Europe. Research papers in Environmental and Spatial Analysis 81, London School of Economics.

Petrakos, G., G. Maier and G. Gorzelak (2000), Integration and Transition in Europe. The economic geography of interaction. Routledge Studies in the European Economy, New york.

Pritchett, L., (1997), "Divergence, big time", *Journal of Economic Perspectives* 11(3), 3-17.

Quah, D., (1996a), "Empirics for Growth and Convergence", *European Economic Review* 40, 1353-1375.

Quah, D., (1996b), "Regional convergence clusters across Europe", *European Economic Review* 40, 951-958.

Quah, D., (1997), "Empirics for growth and distribution: stratification, polarization,and convergence clubs", *Journal of Economic Growth*.2(1), 27-59.

Rodríguez-Pose, A. (1996) Growth and institutional change: The influence of the Spanish regionalisation process on economic performance. Environment and Planning C: Government and Policy, 14(1), 71-87.

Rodríguez-Pose, A. and N. Gill, (2003). Is there a link between regional disparities and devolution? *Research Papers in Environmental and Spatial Analysis* 79, London School of Economics.

Robinson, P., (1988), Root-N-consistent semiparametric regression. *Econometrica* 56: 931–954.

Romer, P.M., (1990), "Endogenous Technological Change", *Journal of Political Economy* 98: S71-S102.

Solow, R.M. (1956), "A contribution to the theory of economic growth", *Quarterly Journal of Economics* 106, 327-368.

Stansel, D. (2005), "Local decentralization and local economic growth: A cross-sectional examination of US metropolitan areas", *Journal of Urban Economics* 57, 55-72.

Tamura, R., (1996), "From decay to growth: a demographic transition to economic growth", Journal of Economic Dynamics and Control 20, 1237-1262.

Temple, J., (1999), The New Growth Evidence, *Journal of Economic Literature* 37(1), 112-156.

Wand, M.P., Jones, M.C., (1995). Kernel Smoothing. Chapman & Hall (eds.), London.

Williamson, J., (1965), Regional inequality and the process of national development. *Economic Development and Cultural Change* 14, 3-45.

Xie D., H. Zou, H. Davoodi (1999), Fiscal decentralization and economic growth in the United States, *Journal of Urban Economics* 45, 228-239.

Tables and Figures

Table 1: Level of national GDP and regional inequalities in Cohesion countries*								
	GDP per capita				***Regional inequalities***			
	1975	1986	1992	2000	1975	1986	1992	2000
Spain	0.83	0.75	0.82	0.83	1.05	1.03	1.06	1.02
Greece	0.72	0.66	0.65	0.69	1.03	0.68	0.75	0.83
Portugal	0.55	0.57	0.69	0.75	1.56	1.19	1.07	1.13
Cohesion	0.82	*0.70*	*0.77*	*0.79*	*1.16*	*1.00*	*1.00*	*1.00*
Rest of the EU15	1.09	*112*	*1.12*	*1.07*	*0.93*	*0.94*	*0.99*	*0.95*

* Figures are relative to the EU15 countries, GDP per capita is measured at PPS
Regional inequalities are measured using the standard deviation of the logarithm of regional GDP per capita
qualities are measured using the standard deviation of the logarithm of regional GDP per capita, the figure for Portugal is for 1977. Values for country groups are in weighted (population) average

Table 2: Summary Statistics for the EU15 countries, 1975-2000				
	GDP per capita		Regional inequalities	
	Mean	Standard Deviation	Mean	Standard Deviation
Austria	1.11	0.02	1.19	0.05
Belgium	1.11	0.03	1.18	0.05
Germany (Western only)	1.20	0.02	0.92	0.04
Spain	0.79	0.03	1.04	0.06
Finland	1.01	0.05	1.12	0.06
France	1.11	0.05	0.75	0.06
Greece	0.68	0.04	0.80	0.09
Italy	1.05	0.02	1.31	0.09
Netherlands*	1.11	0.04	1.01	0.09
Portugal**	0.64	0.07	1.17	0.20
Sweden	1.14	0.08	0.77	0.08
United Kingdom	1.04	0.02	0.75	0.03

Notes: Figures are comùputed relative to the EU25 average
* Regional inequalities computed excluding Groningen region
** Regional inequalities computed excluding Alentejo region

Table 3: Level of national GDP and regional inequalities in new Member States and candidate countries*				
	GDP per capita (EU25=100)		***Regional inequalities***	
	1995	2000	1995	2000
Average	*0.43*	*0.45*	*1.10*	*1.22*
Bulgaria	0.31	0.27	0.96	0.90
Czech Rep.	0.70	0.65	0.95	0.99
Estonia	0.34	0.42	1.52	1.54
Hungary	0.49	0.53	1.09	1.22
Lithuania	0.34	0.38	0.65	0.96
Latvia	0.30	0.35	1.46	2.21
Poland	0.41	0.46	1.43	1.35
Romania	0.30	0.25	0.83	1.06
Slovenia	0.68	0.73	0.60	0.58
Slovakia	0.44	0.48	1.53	1.38

* Figures are relative to the EU15 countries weighted average, weights given by population
GDP per capita is measured at PPS and regional inequalities are measured using the standard deviation of the logarithm of the regional GDP per capita

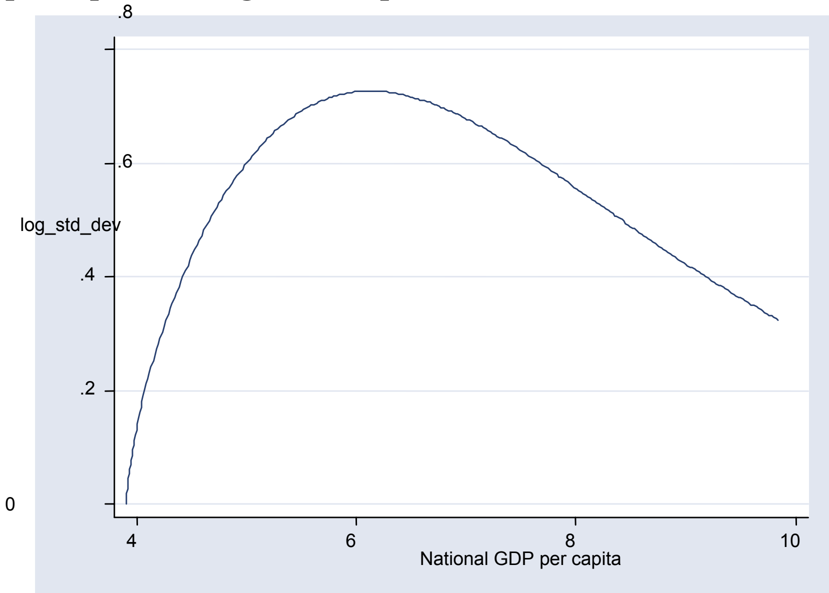
Table 4: Parametric estimations, EU15 1975-2000

dependent variable : Standard deviation of regional regional GDP per capita (GDPc)

	(1)	(2)	(3)	(4)	(5)
GDPc	-0.322*	-0.314*	0.378**	-0.533***	-0.775***
	(0.166)	(0.191)	(0.183)	(0.195)	(0.212)
$GDPc^2$	0.175	-0.032	-0.043	-0.281	-0.515
	(0.278)	(0.321)	(0.319)	(0.322)	(0.365)
Structural Funds	-	-0.036*	-0.046**	-0.053**	-0.024
		(0.020)	(0.021)	(0.020)	(0.027)
Fiscal decent.	-	-0.000	-	-0.001	-0.000
		(0.001)		(0.002)	(0.002)
Fiscal decent. % GDP	-		0.005		
			(0.004)		
Openness	-	0.194	0.209		
		(0.153)	(0.153)		
Real openness	-	-	-	0.651***	0.761***
				(0.183)	(0.186)
Dissimilarity	-	-	-	-	-0.502
					(0.467)
F-test country dummy	68.29	62.82	71.23	71.35	40.93
[P-value]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
R^2	0.76	0.77	0.77	0.78	0.77
# obs	310	287	287	287	240

Notes: (a) time dummies included; (b) standard errors in parentheses; (c) ***, ** and * indicate one, five and ten per cent significance levels respectively, all regressions include a constant term. Variables measured in terms of deviation from the sample average

Figure1: Theoretical analysis of the relationship between National GDP per capita and regional inequalities.



Figures 2-11: Semi-parametric estimations results; *X-axis*: National GDP per capita, *Y-axis*: Standard deviation of regional GDP per capita (deviations with respect to EU average)
The symbols □ and Δ correspond to the optimal band points

Figure 2: Results for EU15, 1975-2000

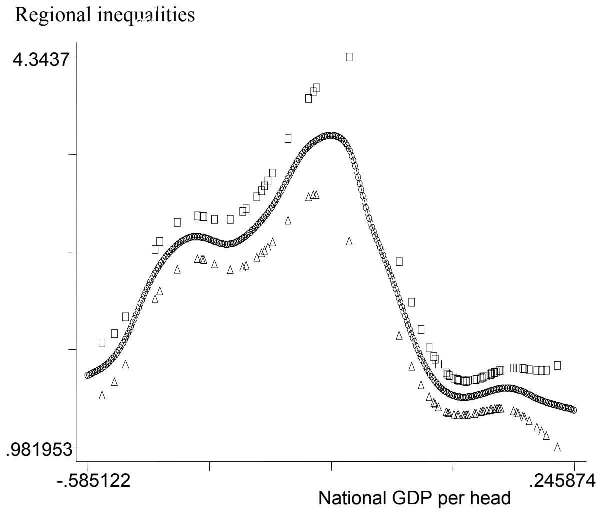


Figure 3: Results for EU15, 1975-2000 – using lagged GDP values (2 and 5 –year lags)

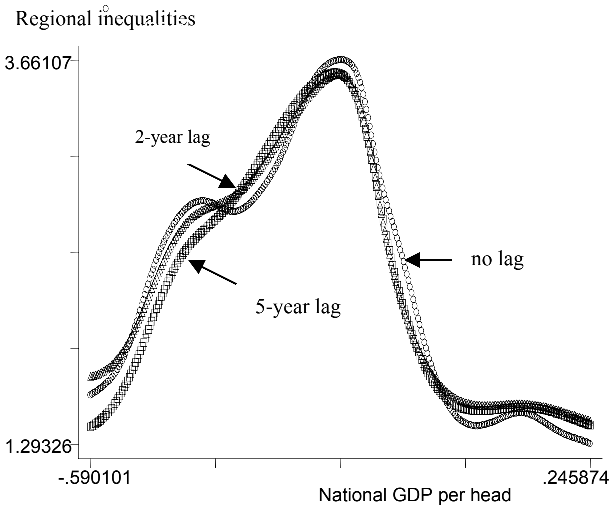


Figure 4: Results for EU25, 1995-2000

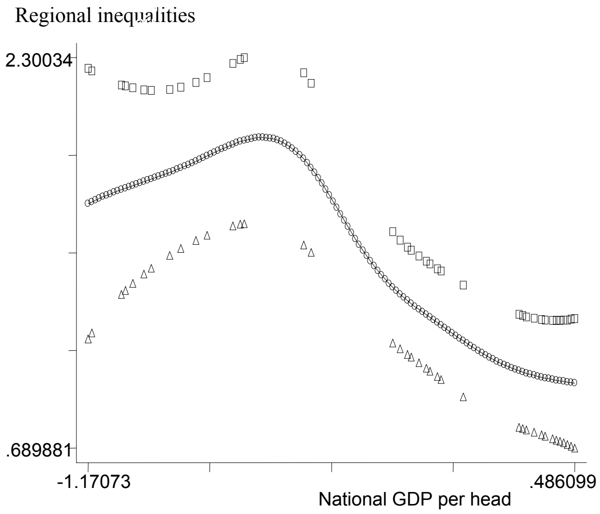


Figure 5: Results for EU25, 1988-2000
inequality measures based on nuts2 regions only

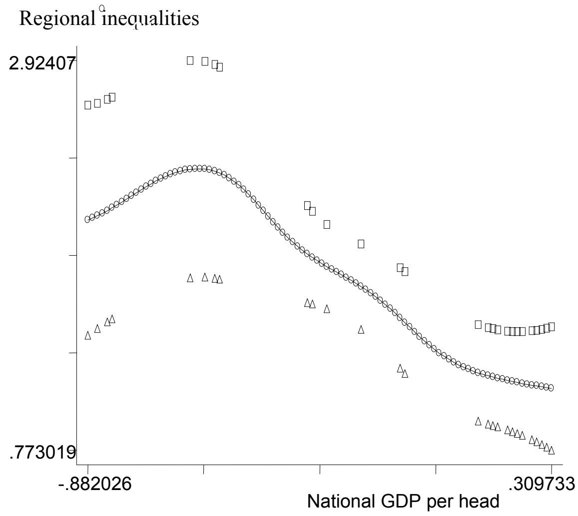


Figure 6: Results based on Functional Urban Areas 1977-1996

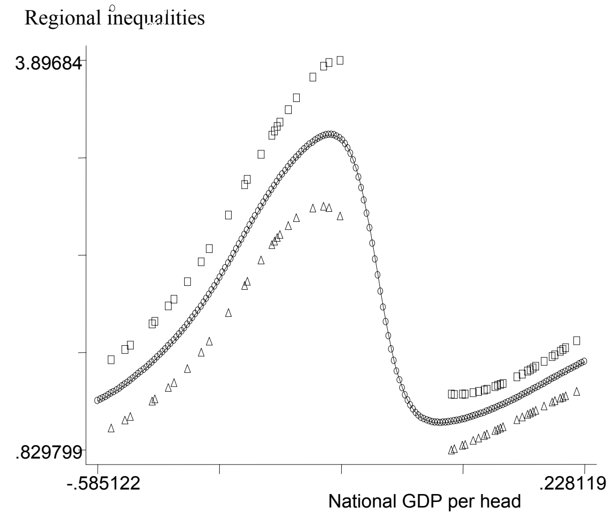


Figure 7: Results based on OECD Territorial Statistics, 1977-1996

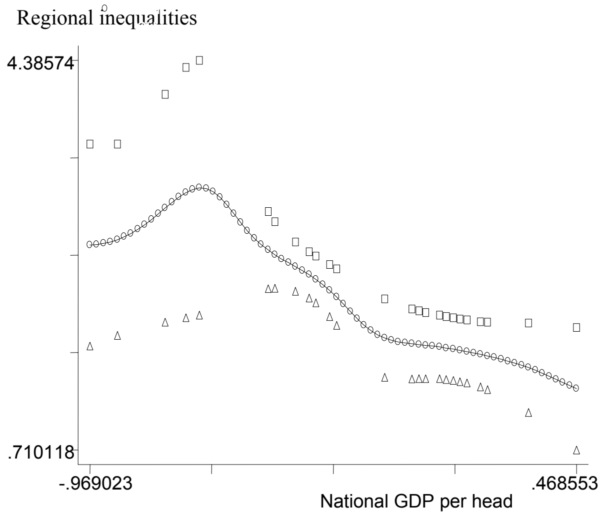


Figure 8: Results for the EU15, 1976-2000,
controlling for fiscal decentr., regional aid and openness

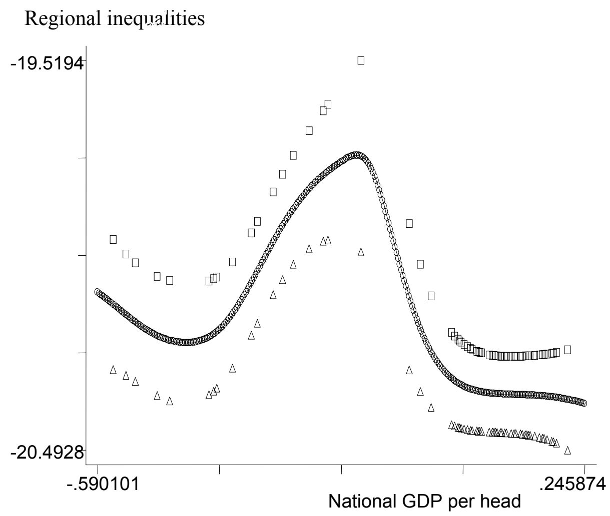


Figure 9: Results for EU15, 1976-2000,
controlling for fiscal decentr. in % of GDP, regional aid and openness

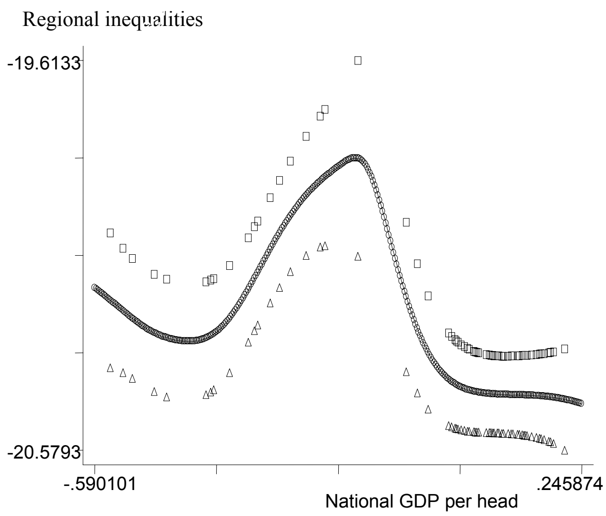


Figure 10: Results for EU15, 1976-2000, controlling *for fiscal decentr., regional aid and Real Openness*

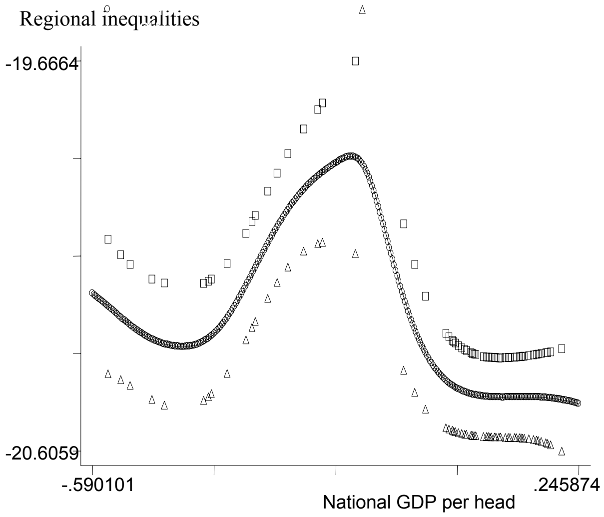


Figure 11: Results for EU15, 1980-2000 *controlling for fiscal* decentralization, regional aid, real *openness and Industrial dissimilarity*

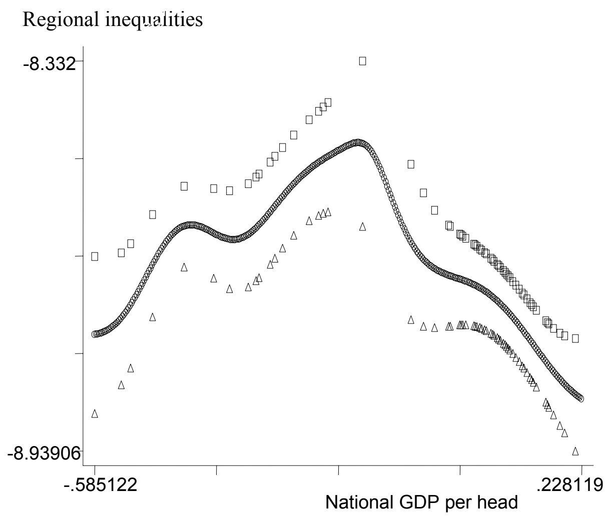


Table A1: Number of regions and dataset used

Country	Eurostat/Cambridge Econometrics database (NUTS2 regions)	Functional Urban Areas	OECD Territorial Statistics
Australia	-	-	8
Austria	9	-	9
Belgium	11	4	3
Canada	-	-	12
Czech Republic	8	-	8
Denmark	-	-	3
Finland	5	-	6
France	22	22	23
Germany	31 (42*)	28	11
Greece	13	-	4
Hungary	7	-	7
Italy	21	17	20
Japan	-	-	10
Mexico	-	-	32
Netherlands	12	4	4
Norway	-	-	7
Poland	16	-	16
Portugal	7	-	7
Slovak Republic	4	-	4
Spain	18	16	18
Sweden	8	-	8
United Kingdom	37	24	-
United States	-	-	51
Total # of observations	312**	180	72

* including new Landers
** 132 for EU25

Table A2: Statistical sources of explanatory variables used in Section 4.3*

Indicator	Definition	Source
Traditional Openness index	$(\text{export}_{i,t}+\text{import}_{i,t})/\text{GDP}_{i,t}$	Ameco database, European Commission, Directorate General for Economic and Financial Affairs
Real openness index	$(\text{export}_{i,t}+\text{import}_{i,t})/\text{GDP}^{p}_{i,t}$ where $\text{GDP}^{p}_{i,t}$ is the GDP expressed in purchasing power standard	Ameco database, European Commission, Directorate General for Economic and Financial Affairs
Tradable openness index	$(\text{export}_{i,t}+\text{import}_{i,t})/\text{GDP}^{t}_{i,t}$ where $\text{GDP}^{t}_{i,t}$ is the GDP of the tradable sectors	Ameco database, European Commission, Directorate General for Economic and Financial Affairs
Industrial dissimilarity index	$K_{i,t} = \frac{1}{0.5\, N_i (N_i - 1))} \sum_{k,k \neq j}^{N_i} K_{j,k}$ where N_i is the number of regions located in country *i* and $K_{j,k,t} = 0.5 \sum_{s} \left| x_{s,j,t} - x_{s,k,t} \right|$ Where $x_{s,j}$= share of sector *s* in total employment of region *j*	Cambridge Econometrics sectors *s* concern agriculture, construction, energy and manufacturing, market services and non-market services
Fiscal decentralization index	Sum of local and regional total expenditures, excluding current and capital transfers to other levels of government, divided by the sum of local, regional and national expenditures, excluding intergovernmental transfers.	World Bank
Fiscal decentralization index (% of national GDP)	Sum of local and regional total expenditures, excluding current and capital transfers to other levels of government, divided by National GDP	World Bank
EU Regional aid	Total EU payment for regional development from the European Regional development Fund (ERDF), the European Agricultural Guidance and Guarantee Fund (EAGGF), , and the European Social Fund (ESF) in % of national GDP	European Commission, Directorate General for Economic and Financial Affairs

* Indicators subscripts indicate country i and year t. Monetary variables are expressed in current euros